INTERNATIONAL STANDARD 3456

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Aircraft — Lever-operated manual switches (Class 3) — Performance requirements

Aéronefs — Interrupteurs à levier à commande manuelle (classe 3) — Caractéristiques

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3456 was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and circulated to the Member Bodies in August 1974.

It has been approved by the Member Bodies of the following countries :

Australia	Poland	United Kingdom
Belgium	Romania	U.S.A.
Canada	South Africa, Rep. of	U.S.S.R.
Germany	Spain	Yugoslavia
Mexico	Turkey	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

France
Italy

Printed in Switzerland

Aircraft — Lever-operated manual switches (Class 3) — Performance requirements

1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard specifies the performance requirements for single- and triple-hole mounting, lever-operated manual switches Class 3 for use in nominal 28 V d.c. and 115/200 V three-phase, 400 Hz a.c. systems in aircraft.

1.2 The switches are environmentally sealed and suitable for higher altitude and temperature conditions than are Class 2 switches which are sealed only at the lever entry. They do not have the positive action features of the Class 1 and Class 2 switches specified in ISO 1466.

2 REFERENCES

ISO/R 224, *Standard form of declaration of performance of aircraft electrical equipment.*

ISO 1466, *Lever-operated manual switches for aircraft — Performance requirements.*

ISO 1540, *Aircraft — Electrical power systems — Characteristics.*[1)]

ISO 3282, *Aircraft — Dimensions for single- and triple-hole mounting (Class 3) lever-operated switches.*[1)]

Environmental tests for aircraft equipment :

ISO 2650, *Part 1 — Scope and applicability.*

ISO 2651, *Part 2.1 — Temperature, pressure and humidity.*[1)]

ISO 2652, *Part 2.2 — Humidity (24 h cycle).*[1)]

ISO 2655, *Part 2.5 — Waterproofness.*

ISO 2658, *Part 2.8 — Mould growth.*

ISO 2668, *Part 3.1 — Vibration.*[2)]

ISO 2669, *Part 3.2 — Constant acceleration.*[2)]

ISO 2683, *Part 5.1 — Explosion proofness.*[1)]

ISO 2684, *Part 5.2 — Fluid contamination.*

3 DESIGN REQUIREMENTS

3.1 The switch shall be suitable for use at altitudes up to 20 000 m and at temperatures within the range − 40 °C to + 70 °C, and shall not suffer damage or deterioration when subjected to storage temperatures in the range − 65 °C to + 85 °C.

3.2 The switch shall be suitable for mounting through the panel from the rear and shall operate satisfactorily when mounted in any attitude. Other methods of mounting are permissible if specified in the applicable individual specification.

3.3 The switch may be the two- or three-position type, with one or more poles; it may be self-retaining and/or spring-return. It should preferably be designed to allow the incorporation of integral locking of the lever in any or all positions.

3.4 The method of operation of the switch shall be by means of a single lever, moving in a plane perpendicular to the mounting panel. The relationship of the lever positions to the keyways, and the relationship of the terminal numbers to the lever positions shall be stated in the individual specification.

3.5 The switch terminals shall be identified by number in the sequence shown in the individual specification.

4 DIMENSIONS

The envelope and fixing dimensions for the switch shall comply with ISO 3282.

5 OPERATION

5.1 It shall not be possible to rotate the lever about its longitudinal axis, unless otherwise specified in the applicable individual specification.

1) At present at the stage of draft.

2) In preparation.

5.2 The angular movement of the lever shall be in accordance with ISO 3282 or other applicable individual specification.

5.3 The lever shall be capable of withstanding without damage or distortion a force of 90 N applied steadily in the directions stated in 10.2.2.

5.4 There shall be at least a 4° movement of the lever before switching occurs.

6 CONSTRUCTION

6.1 The lever, including any metal inserts, shall be insulated from all live parts.

6.2 The force required to operate the switch shall be not less than 2,7 N and not more than 45 N. For each operation of a particular type of switch, the maximum force shall not exceed the minimum force by more than 200 %. This maximum-to-minimum force value does not apply to spring-return switches.

6.3 Where locking of the lever is provided, it shall be positive and automatic, and the lock shall be released by raising the lever against a spring force of 6,7 to 22 N.

6.4 The exposed portion of the switch shall have a non-glaring finish.

6.5 The switch shall be environmentally sealed and shall meet the switch sealing test requirements of 10.14.

6.6 Terminations shall be by screws, or other approved means, for example integrated terminal junctions. If screws are used, the threads shall be of size M4 × 0,7 or No. 6 UNC and be capable of accepting two crimped tag-type terminations of approved design. Integrated terminal junctions shall be of an approved design and suitable for size 16 cables. Terminals shall have a mechanical strength adequate to satisfy the requirements of 10.2.1.

6.7 The terminal arrangement shall be such that wiring access is still provided when the switches are mounted in rows at minimum spacing.

The switches, when properly installed, shall be suitable for close mounting and shall not constitute an electrical hazard if the side faces of adjacent switches touch one another.

6.8 The switch shall be mounted either :

a) by means of a threaded bush, with a locating keyway in the plane of movement of the lever, suitable for use with the panel mounting hole specified in ISO 3282. Two hexagon mounting nuts, one locating washer and one internal tooth-lock washer shall be provided with each switch; or

b) by means of two M4 × 0,7 screws passing through the mounting panel as specified in ISO 3282.

6.9 The switch shall be so constructed that it is suitable for performing at least 20 000 operations at maximum rated current and voltage.

6.10 The make-and-break of the contacts shall be only that intended by the explicit lever movement. Spring-return switches shall return from their momentary position solely by the internal mechanism of the switch.

7 VOLTAGE AND CURRENT RATINGS

7.1 Voltage ratings

The switch shall be suitable for operation in nominal 28 V d.c., 115 V single-phase and 115/200 V three-phase, 400 Hz a.c. systems having the characteristics specified in ISO 1540. In addition, the switch shall be suitable for use at voltages down to 4 V d.c. or a.c.

7.2 Current ratings

The switch shall be suitable for all of the following nominal current ratings :

tungsten filament lamp load (d.c)	4 A
resistive load (d.c)	15 A
inductive load (d.c) (40 mH inductance)	10 A
tungsten filament lamp load (a.c)	2 A
resistive load (a.c)	11 A
inductive load, 0,70 power factor lagging (a.c)	7 A

7.3 In addition, unless otherwise declared, the switch shall be suitable for operation at 100 mA resistive load at voltages down to 4 V.

8 ENVIRONMENT

The switch shall comply with the requirements of ISO 2650, ISO 2651, ISO 2652, ISO 2655, ISO 2658, ISO 2668, ISO 2669, ISO 2683 and ISO 2684.

9 TESTS

9.1 Except where specific details are listed below, tests shall be in accordance with the practice and requirements of relevant national specifications for aircraft switches. Evidence shall be available to the purchaser that switches identical to those supplied as covered by this International Standard have satisfactorily passed type tests conducted in accordance with clause 10. In order that a consistent standard of quality be maintained, the manufacturer shall conduct production routine tests and production quality tests, the minimum requirements for which are indicated in clauses 11 and 12.

9.2 All tests referring to a.c. voltages relate to 115 V with 200 V (line to line) for multi-pole switches, and to 115 V (phase) for single-pole switches.

All electrical tests shall be performed with the switch connected on each side with cable of a cross-section compatible with the required current. Except for the test in 10.10, each cable shall be 900 ± 50 mm (36 ± 2 in) in length and shall be attached to the switch using a crimped termination of an approved design.

9.3 Unless otherwise stated, the tests shall be made at a temperature of 15 to 30 °C, a pressure of 93 to 106 kPa (930 to 1 060 mbar), and at a relative humidity not exceeding 90 %.

9.4 The cycle of operation for mechanical testing shall consist in movement of the lever from one extreme position to the other and return to the original position. Levers of switches of the spring-return type shall be allowed to return to the biased position without hindrance or assistance from the operating device. The times spent in each position shall be approximately equal. The cycle of operation for electrical tests shall consist of the necessary lever movement to cause one making and one breaking of the contacts under test.

10 TYPE TESTS

10.1 General

Type tests shall be made on switches which have previously passed the production tests. For the purposes of this International Standard, switches of single-pole, double-pole, three-pole and four-pole construction are considered as basic types of switch. Each basic type of switch shall be subjected to type tests in accordance with a schedule to be agreed with the relevant Approving Authority. It is not intended that variants of a basic type of switch should be subjected to all of the tests : the extent of the type tests on such switches shall be agreed between the manufacturer and the Approving Authority.

10.2 Mechanical strength tests

10.2.1 *Strength of terminals*

All terminals shall be separately subjected for not less than 1 min to :

a) a pull of 45 N in each of the following directions :

— parallel to the long axis of the terminal screw or terminal junction

— at right angles to the long axis of the terminal screw or terminal junction

(no one terminal shall be tested in more than one direction);

b) a torque of 1,8 N·m applied to the terminal screw.

10.2.2 *Strength of lever*

A 90 N load shall be applied for not less than 1 min to the lever under each of the following conditions, during which the switch shall be connected electrically to check contact operation :

a) perpendicular to the lever axis and parallel to the line of lever travel at each end-position of the lever;

b) perpendicular to the lever axis and perpendicular to the line of travel in both directions throughout the entire range of lever travel;

c) coaxial with the lever axis toward and away from the switch body throughout the entire range of lever travel;

d) for locked lever switches, perpendicular to the lever axis in the plane of travel and in the direction to cause operation. The lever shall remain in the locked position.

For the tests in a), b) and c) the load shall be applied 3 mm from the tip of the lever.

10.2.3 *Strength of panel mounting bush*

A tightening torque of 2,9 N·m shall be applied for not less than 1 min to the mounting nut with the switch mounted in a panel and located by means of the locating washer and keyway.

10.2.4 *Requirements*

The switch shall not be damaged or distorted as a result of the tests in 10.2.1 to 10.2.3, immediately following which it shall

a) satisfy the requirements of the insulation resistance test (see 10.6);

b) perform satisfactorily 10 cycles of operation at 28 V d.c. resistive load;

c) satisfy the requirements of the switch sealing test (see 10.14).

10.3 Operating forces test

The forces necessary for the operation of the switch to all operating positions shall be determined. The force shall be applied at 3 mm from the tip of the lever and at right angles to the lever axis. The test shall be repeated three times in each lever direction. The forces to operate and, if appropriate, to unlock the lever shall be within the declared limits.

10.4 Mechanical endurance tests

Two switches shall be subjected to 40 000 cycles of no-load operation as follows, at a rate of operation between 10 to 18 cycles per minute.

a) 30 000 cycles at + 20 ± 5 °C

b) 5 000 cycles at + 70 ± 2 °C

c) 5 000 cycles at − 40 ± 2 °C

NOTE — For spring-return switches, return from the momentarily actuated position is to be accomplished solely by the internal mechanism of the switch without hindrance or assistance by the operating device. When testing other types, the operating device is not to impart a load to the switch lever in any fixed position of the lever.

Following these tests, the switches shall satisfy the requirements of the voltage drop and insulation resistance tests specified in 10.5 and 10.6, and there shall be no mechanical breakage, malfunction, or deterioration of the switch, when tested in accordance with 10.2, 10.3 and 10.14.

10.5 Voltage drop test

With a test current of 100 mA resistive at 2 to 4 V d.c. flowing through the contacts, the voltage drop across the switch terminals shall be measured and shall not exceed 2,5 mV initially and 5 mV after mechanical endurance.

10.6 High voltage and insulation tests

The switch, mounted on a metal plate, shall be subjected to the tests specified in 10.6.1 and 10.6.2.

10.6.1 *High voltage test*

A test voltage of 1 500 V r.m.s. 50 to 60 Hz shall be applied for not less than 5 s between

a) each terminal and all others not connected to it, with the lever in each position;

b) all terminals connected together and the metal mounting plate and any exposed metallic parts with the lever in each position.

The voltage shall be increased and decreased gradually.

10.6.2 *Insulation resistance test*

Immediately following the tests specified in 10.6.1, the insulation resistance shall be measured at a potential of 500 V d.c. between the points specified in 10.6.1 a) and b) and shall not be less than 100 MΩ.

10.7 Temperature rise test

10.7.1 The switch, suspended in still air, shall carry the electrical test current until steady conditions are reached. The temperature or temperature rise of any external part of the switch shall not exceed the figures stated in 10.7.2 and 10.7.3. The temperature rise in the attached cable (measured with a suitable thermocouple at the surface of the conductor beneath the insulation at a point 25 mm (1 in) from the end of the insulation) shall not exceed 55 °C. For multi-pole switches the temperature shall be measured with all normally closed poles carrying rated current.

10.7.2 The temperature of any component part of the switch which may normally be accessible to, or inadvertently touched by, occupants of the aircraft under operating conditions shall not exceed 100 °C at maximum ambient temperature.

10.7.3 The temperature rise of any part which is necessarily handled and which is made from, or covered with, material which is a poor thermal conductor shall not exceed 20 °C. If such a part is made from metal, the temperature rise shall not exceed 10 °C.

10.8 Electrical endurance tests

10.8.1 Two separate switches shall be subjected to each electrical load rating specified in clause 7 for 20 000 cycles of operation as follows at a rate between 10 and 18 cycles per minute :

a) 10 000 cycles at sea level;

b) 9 500 cycles at a pressure corresponding to an altitude of 11 000 m;

c) 500 cycles at a pressure corresponding to an altitude of 20 000 m.

10.8.2 Two switches shall each be subjected to 40 000 cycles of operation as follows at the rate specified in 10.8.1, carrying a 100 mA resistive load at 2 to 4 V d.c. :

a) 20 000 cycles at sea level;

b) 20 000 cycles at a pressure corresponding to an altitude of 6 100 m.

10.8.3 Following the tests in 10.8.1, the switches shall be subjected to the temperature rise test specified in 10.7. There shall be no mechanical breakage or damage to the switch mechanism and the switches shall meet the requirements of 10.7.

10.9 Overload test

10.9.1 The switch shall be subjected to 50 cycles of operation at the apropriate rate specified in 10.8.1 controlling 150 % resistive current at 28 V d.c.

10.9.2 The switch shall be subjected to 50 cycles of operation at the appropriate rate specified in 10.8.1 controlling 150 % resistive current at 115/200 V a.c.

10.10 Short-circuit test

10.10.1 Switches shall be subjected to the following short-circuit test in a circuit equivalent to that shown in the figure. The circuit shall be adjusted to provide a current of 60 times the rated resistive current at 28 V d.c. with the selector switch in the calibrate position. For three-position switches, a separate switch may be used for testing each operating position.

10.10.2 The switch under test shall be inserted in the test circuit with its contacts closed, the selector switch set to test, and the circuit-breaker closed. The control switch shall then be closed to initiate the fault current and held closed until the circuit-breaker clears the fault. The fault current shall be applied five times with a miminum interval of 2 min between each test. The contacts shall not weld or stick and there shall be no mechanical damage to the switch. After the test the voltage drop across the contacts shall be measured in accordance with 10.5 and shall not exceed 2,5 mV.

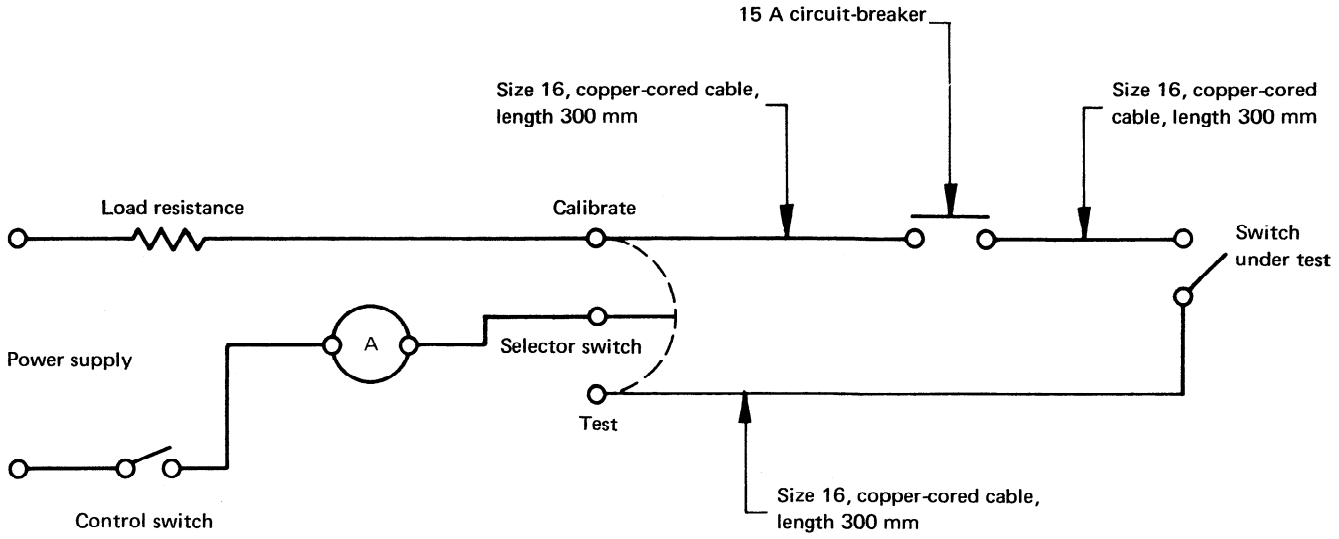

FIGURE – **Typical test circuit for short-circuit test**

10.11 Vibration test

10.11.1 The switch shall be subjected to the appropriate category of vibration test specified in ISO 2668.

10.11.2 Resonance tests shall be conducted with the switch contacts in each of the two or three positions, as appropriate, with 28 V d.c. applied across normally open contacts and with 15 A d.c. passing through closed contacts. The open contacts shall not close during the tests, and the voltage drop across closed contacts shall not exceed 200 mV, oscillographic methods being used to check compliance with this requirement.

10.11.3 For equal times during the endurance tests (fatigue test) cycles, the switch shall remain in each of its self-retaining positions. Throughout the test 15 A d.c. shall be passed through any closed contact.

10.11.4 At the conclusion of the tests the switch shall satisfy the requirements of the high voltage and insulation resistance tests specified in 10.6.

10.12 Acceleration test

10.12.1 The switch shall be subjected to the appropriate functioning acceleration test specified in ISO 2669 with the switch contacts in each of the two or three positions, as appropriate. A check shall be made to verify that there is no inadvertent opening or closing of the contacts during the tests, as indicated by a test lamp or other suitable device. Throughout the test 28 V d.c. shall be applied across normally open contacts, and 15 A d.c. shall be passed through closed contacts.

The test shall be repeated with the switch in each self-retaining position.

10.12.2 The switch shall be subjected to the appropriate structural integrity tests specified in ISO 2669 in each of the two or three self-retaining positions.

10.12.3 At the conclusion of the tests the switch shall satisfy the requirements of the insulation resistance test specified in 10.6.

10.13 Climatic tests

The switches shall be subjected to the appropriate temperature-pressure tests specified in ISO 2651.

Three sample switches shall be tested respectively at 4 V d.c., 28 V d.c. and 115/200 V a.c. with contacts closed during the functioning periods, and the circuits shall be arranged so that when closed the first sample carries a 100 mA load, the second and third samples 15 A loads. Except during the functioning tests, the appropriate test potential shall be left connected to the normally open contacts.

The functioning tests shall be performed as follows :

Ten cycles of operation of the switch shall be performed over a period of 1 min. Immediately following this, the voltage drop measured in accordance with 10.5 shall not exceed 5 mV.

For the purposes of these tests, the declared altitude shall be 20 000 m.

At the conclusion of the test cycles the insulation shall be not less than 20 MΩ and after 24 h at room temperature it shall be not less than 100 MΩ.

10.14 Switch sealing test

The switch shall be subjected to the leakage test specified in ISO 2655 with the lever in each self-retaining position.

At the conclusion of the test and after removal of moisture by wiping, the voltage drop, measured in accordance with 10.5, shall not exceed 2,5 mV and the insulation resistance shall be not less than 20 MΩ between terminals and switch ferrule.

10.15 Resistance to aircraft fluids

Tests shall be made to ensure that the materials used in the switches are resistant to the various aircraft fluids, in accordance with the requirements of ISO 2684.

10.16 Strip examination and report

Upon completion of the type tests each sample switch shall be opened and examined for any signs of excessive wear. A report of the condition of each switch shall be submitted to the Inspecting Authority.

10.17 Thermal cycling test

This test is designed to determine the ability of switches to withstand extremes of high and low temperature and the shock of alternate exposure to these extremes. Separate chambers shall be used for the high and low temperatures. A cycle shall consist in the switch being placed in the low temperature chamber for 1 h at −65 °C, exposure to normal ambient temperature of 25 °C for not more than 5 min, exposure in the high temperature chamber for 1 h at + 100 °C, and exposure to normal ambient temperature of 25 °C for not more than 5 min. The switch shall be subjected to 3 cycles after which it shall be examined for mechanical and electrical damage and ability to conduct current. There shall be no damage and the switch shall be conductive at 4 V.

11 PRODUCTION TESTS

11.1 Markings and operation

Each switch shall satisfy the requirements of 5.1 to 5.4 and clause 14.

11.2 Operating force test

Each switch shall satisfy the requirements of the test specified in 10.3.

11.3 Voltage drop test

Each switch shall satisfy the requirements of the test specified in 10.5.

11.4 High voltage and insulation tests

Each switch shall satisfy the requirements of the tests specified in 10.6.

12 QUALITY TESTS

12.1 Selection of samples

Sixteen switches, or 1,0 % of the batch, whichever is the greater, shall be taken at random from each batch of each basic type of switch manufactured in compliance with this International Standard. The system for batching production shall be agreed between the manufacturer and the purchaser or Inspecting Authority, as appropriate, and declared. The samples shall be taken from switches which have previously been subjected to the production tests specified in clause 11 and which have passed these tests.

If any sample fails to fulfill the requirements of the tests, the batch shall be segregated and the cause of failure investigated. At the discretion of the Inspecting Authority, further samples may be taken from the batch and tested. If these fail to pass the tests, the batch shall be deemed not to comply with this International Standard.

12.2 Electrical endurance test

Half of the sample switches shall be subjected to electrical endurance tests as specified in 10.8.1 carrying a 15 A resistive load at 28 V d.c.

12.3 Vibration test

The remaining half of the sample switches shall be subjected to resonance tests in accordance with 10.11 followed by 10 h tests at each of any resonant frequencies detected during type tests.

12.4 Sealing test

The switches shall satisfy the requirements of the test specified in 10.14.

12.5 Strip examination and report

Each sample switch shall be examined in accordance with 10.16.

13 DECLARATIONS

The declarations made by the manufacturer in accordance with ISO/R 224 shall include :

a) classification;

b) the limits of the forces necessary to operate the switch to any position;

c) switch operation relative to lever position and terminal numbering;

d) the system of batching used for quality test sampling.

14 MARKING

In addition to the terminal numbering, the following minimum information shall be clearly and indelibly marked on each switch :

a) national standard number, and classification;

b) manufacturer's name or identification;

c) manufacturer's type number;

the number of this International Standard.